

and homeward. In two or three days we saw the twinkling lights of some village shore, and on September 23rd we docked at Halifax.

The best remembered aspects of the trip were the things less tangible than molluses, although these are good in their place. The bare sweep and the quietness of the hills; the cheerfulness of that sturdy, enterprising people, the Eskimo, as they helped us in our work or gathered around our stove in the evening for warmth and companionship, coffee and cigarettes; and last, and perhaps best of all, the way Jimmy Bell, man of the Hudson's Bay Company, and our other neighbors at Lake Harbour, adopted us into their midst, aided us in our endeavors and entertained us in the hearty hospitality of the north.

CIVILIZATION AND AQUATIC MOLLUSKS

BY CALVIN GOODRICH

Studies of Dr. Victor Sterki (1911) and Dr. Allan Archer (1937) upon the adaptiveness of American molluscs to agricultural, industrial and urban environments were devoted almost wholly to the adjustments made by terrestrial forms, and in fact particulars in regard to aquatic species were entered into only in the case of the introduced *Bythinia tentaculata*. It is proposed here to deal with adaptations among fresh-water mollusks either observed personally or chanced upon in random reading. Since both Sterki and Archer have used the word "civilization" in the titles of their papers I am venturing to echo them, for all that currently doubt is entertained about the existence of that state of affairs.

Lymnaca. The favored habitat of *L. humilis modicella* and *obrussa* in the middle west is mud flats of pasture brooks and ponds. The snails are not adversely affected by the accumulation of silt in their gills and by high summer temperatures. Judging by their numbers they have prospered better than has *L. caperata* which I recall as once associated with them in ditches and now is seldom met with. *L. columella* has been found in southern waters locally described as "hog creeks," appearing there to be the only mollusks. An extremely turbidity and per-

haps some farmyard pollution have been insufficient to bring about their extinction. As long ago as 1854, Dr. J. P. Kirtland reported the occurrence of *L. megasoma* in the Mahoning River at Alliance, Stark Co., Ohio. When a few years ago a collector came to notice at Alliance, I asked him to look for the species. He found it in fair numbers. The locality is in an industrialized area and *megasoma*, which usually is thought of as belonging to unaltered sub-boreal regions, might have been expected to perish in such a place. It has done so in a bay of Lake Huron where it was abundant in 1922, but not found living eleven years later. The marshes it occupied have been made a dumping ground by summer cottagers. Even a slight pollution is enough apparently to destroy *L. stagnalis appressa* of inland lakes of southern Michigan, and it has seemed to me that *L. palustris* has been reduced by the same sort of contamination. On the other hand, *L. reflexa*, large and free of the common ferruginous deposit, has been scooped from the discharge of a city sewer.

Helisoma. The species *H. trivolvis* may be rated as intrinsically adaptive inasmuch as it lives under a variety of conditions even where the natural environments have not been disturbed. It has extended the range of its habitats to water tanks, watering troughs, field drains and like artificialities. Innumerable takings of aquatic materials in the course of studies of fish food that have been examined have almost always contained examples of *H. antrosom* (*H. anceps*), and that probably points also to inherent adaptiveness. A much more intolerant species is *H. campanulatum*, and I am inclined to believe that it is becoming rarer as human occupancy increases.

Physa. The appearance and disappearance of colonies of this genus from one year to another make it difficult to decide whether it can adjust itself successfully to the newer conditions, a point that might, of course, be settled if the generations in any one spot were continuous. *P. integra* has been found in a stream that for a while came under hearty condemnation in municipal reports for carrying more domestic wastes than natural waters. Existence there may, however, have been only temporary. Van Hyning (1904) tells of finding *P. gyrina* so crowded in a spot that the individuals were wedged together into an immovable mass. I

myself found a similarly dense population of the species in a shallow roadside ditch in northern Indiana. The reflection of sun rays made the shells noticeable from a moving car. The favorable conditions to reproduction, whatever they were, were man-made.

Ferrissia. Numbers of *F. tarda* have been seen on stones of a polluted river which for a stretch of miles seemingly contained no other mollusks.

Pulmonates in general. Oil wastes in the lower part of the Detroit River led to the filing of a lawsuit, an outstanding complaint of which was that fishing had been ruined. The respondent caused a survey to be made of the organic life of the area affected. It was learned that domestic sewage associated with the oil increased the nitrates and that these in turn increased vegetation, phytoplankton and surface-living snails, the reaction on fish life being altogether beneficial. While the pulmonates *L. catascopium* and *H. trivolvis* were discovered to be in vast numbers, the bottom-dwellers, operculates and pelecypods, were nowhere found living within the polluted tract.

Valvata. Specimens of *V. tricarinata* were taken with *P. integra* in the extremely polluted stream above mentioned. Richardson (1925) studied the progressive contamination of the Illinois River, which carries the refuse of Chicago. The expansion called Peoria Lake showed a greater destructive action on living organisms than parts below it, and the occupants of this lower section, while still having to adapt themselves to fouled conditions, were spoken of as "cleaner preference species." Among these were *V. tricarinata*.

Bythinia. The introduced *B. tentaculata* (reintroduced in F. C. Baker's belief) has kept so closely to the shores of the Great Lakes during its occupancy of the region as to seem limited in its range of habitats to clean, or fairly clean, waters. Yet within the last two or three years Mr. Charles D. Nelson has been finding it in the polluted Grand River at Grand Rapids, Michigan. This is about forty miles upstream from the river's discharge.

Campeloma. Richardson (1925) dredged *C. subsolidum* in parts of the Illinois which he described as having "bad odor and abundant bubbling."

Pleurocera acuta and *Goniobasis livescens*. Listed by Richardson as "cleaner preference species" of the Illinois River. Inasmuch as these two species were among the aquatic mollusks that early advanced into the glaciated area, indicated by Pleistocene deposits, they may be considered innately adaptive and so are perhaps more resistant to polluted conditions than most other Pleuroceridae. The "winter-kill" in the case of *Goniobasis* may be due to toxins liberated under the ice by decaying algae and a sharp decrease in the amounts of dissolved oxygen as well as to floods or which human agencies can be held responsible. It is difficult in the circumstances to say whether natural conditions or artificial bring about the destruction sometimes to be noted by windrows of shells on beaches in the spring.

Unionidae. Three species of *Lampsilis* and one of *Plagiola* were living in the Illinois River in 1923 in the parts defined by Richardson as favorable for the "cleaner preference species."

Sphaeriidae. Richardson reported that *Musculium transversum* had been enormously prolific in the excessively tainted Peoria Lake. Numbers sometimes ran to 100,000 to the square yard in 1922. Repetition of dredgings disclosed that populations increased from 50 to 2000 fold in the period of two years. Oxygen available for organisms was very low. Carp which had made *Musculium* an important part of their food had been driven out. Below the lake, four species of *Sphaerium* and four of *Pisidium* were found living.

A phase of survival under conditions set up by the new "culture" has an appearance of adaptiveness that is probably deceptive. This may be illustrated by three instances. *Ligumia recta latissima* lives in an upstream part of the Huron River of southern Michigan, *Lampsilis ventricosa* occupies an old millrace of the River Raisin below Tecumseh, Lenawee County, Michigan, and *Goniobasis cahawbensis* and *carinocostata* are in an impounded part of the Little Cahaba River, Jefferson County, Alabama. All specimens taken of the four species were adult, healthy, thick-shelled and without malformation. Yet no young were seen. It is clear that reproduction has stayed, nullified or rendered impossible. A plausible explanation as applying to the mussels is provided by M. M. Ellis (1931). In partially

polluted streams wherein he was seeking breeding stock he found plenty of living Unionidae, but a large percentage of the gravid females thereof were heavily infested with bacteria and infusoria. A result was that “. . . most of the gloecidia were either destroyed leaving only the empty shells in the marsupia or were reduced to an enfeebled condition. . . .” It is reasonable to believe that the two species of *Goniobasis* of Alabama were undergoing a similar restraint on propagation.

REFERENCES

- ARCHER, A. F., “Civilization and Land Mollusks of Ohio,” *Nautilus*, 50 (1937), 117-121.
- ELLIS, M. M., “Some Factors Affecting the Replacement of the Commercial Fresh-Water Mussels,” U. S. Bureau of Fisheries Circular 7 (1931), 7.
- RICHARDSON, R. E., “Changes in the Small Bottom Fauna of Peoria Lake, 1920 and 1922,” *Bull. Natural History Survey of Illinois*, 15, Art. 5 (1925), 350-51, 380-81.
- RICHARDSON, R. E., “Illinois River Bottom Fauna in 1925,” *Bull. Natural History Survey of Illinois*, 15, Art. 6 (1925), 402-03, 415-16.
- STERKI, V., “Civilization and Snails,” *Nautilus*, 24 (1911), 98-101.
- VAN HYNING, T., “A Molluscan Stampede,” *Nautilus*, 18 (1904), 31-32.

THE SNAILS OF TED CAVE, TENNESSEE

BY LESLIE HUBRICHT

Ted Cave is situated on the west bank of Caney Fork River, about five miles east of Smithville, DeKalb Co., Tennessee. It is an ugly cave, without any of the formations which make many so attractive. The floor is littered with slabs of rock fallen from the roof, and over these is deposited a layer of slippery mud acquired when the river rose and flooded the cave. It has nothing to attract the tourist, but to the couchologist and evolutionist it is of great interest.

The mouth of the cave is a large opening on the bluff about twenty-five feet above the river. On the right hand side, a short distance within, is an opening in the floor through which a stream may be seen about twenty feet below. This is Fall Creek, which